

Notice of Allowability

Application No.

10/053,288

Applicant(s)

DALTON ET AL.

Examiner

Art Unit

Hsien-Ming Lee

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 7/28/03.
2. ☒ The allowed claim(s) is/are 1, 3-7, 9-16 and 18-20.
3. ☒ The drawings filed on 7/28/03 are accepted by the Examiner.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
- * Certified copies not received: _____.
5. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.
 - (a) ☐ The translation of the foreign language provisional application has been received.
6. ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application. **THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.**

7. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
8. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No. _____.
 - (b) ☐ including changes required by the proposed drawing correction filed _____, which has been approved by the Examiner.
 - (c) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No. _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the margin according to 37 CFR 1.121(d).

9. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

- | | |
|--|---|
| 1 <input type="checkbox"/> Notice of References Cited (PTO-892) | 5 <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 2 <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 6 <input type="checkbox"/> Interview Summary (PTO-413), Paper No. _____ |
| 3 <input type="checkbox"/> Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No. _____ | 7 <input type="checkbox"/> Examiner's Amendment/Comment |
| 4 <input type="checkbox"/> Examiner's Comment Regarding Requirement for Deposit of Biological Material | 8 <input checked="" type="checkbox"/> Examiner's Statement of Reasons for Allowance |
| | 9 <input type="checkbox"/> Other |

DETAILED ACTION

Remarks

1. Applicant's cancellation to claims 2, 8 and 17 is acknowledged. Claims 1, 3-7, 9-16 and 18-20 are pending in the application.
2. The objection to drawing and claim 16; 102(e) rejection and 103(a) rejection as set forth in the previous Office Action are withdrawn.

Allowable Subject Matter

3. Claims 1, 3-7, 9-16 and 18-20 are allowed.
4. The following is an examiner's statement of reasons for allowance:

The prior art of record, Fornof et al. (US 6,537,908), teaches a method for forming a metal pattern in a substrate, the method comprising the steps of:

- depositing a lower hardmask layer 56' on the substrate 50/52', the lower hardmask layer 56' having a dielectric constant less than about 4.5 (Fig.2B);
- depositing a middle hardmask layer (not shown) on the lower hardmask layer 56' (i.e. when hardmask 54 includes more than two layers, it would have the middle hardmask layer disposed between lower and top hardmask layers, col.3, lines 52-54);
- depositing a top hardmask layer 58' (i.e. a patterning layer) on the middle hardmask layer, the top hardmask layer 58' having a thickness less than about 200 Å (i.e. 100 ~1,000 Å, col. 5, lines 36-39);
- forming a first opening 60 in the top hardmask layer 58' in accordance with a first pattern, thereby exposing a portion of the middle hardmask layer;

- forming a second opening 62 in said portion of the middle hardmask layer and a portion of the lower hardmask layer 56' in accordance with a second pattern and a corresponding opening in the lower hardmask layer 56', thereby exposing a portion of the substrate 52'/50 (Fig.2D);
- forming an opening 64 in the substrate 52'/50 (Fig.2E);
- depositing metal 68 (copper) in the opening 64 in the substrate 52'/50 (Fig.2F); and
- removing the top hardmask layer 58' (Fig.2F).

In contrast, Fornof et al. neither teach nor suggest that the top hardmask is of a material selected from the group consisting of refractory metals, refractory metal nitrides, refractory metal alloy, doped amorphous silicon and doped silicon; and depositing the top hardmask layer using a vapor deposition process. Instead, Fornof et al teach that the top hardmask layer is a cured patterning layer.

Dalton et al. (U.S. Application Number 09/550,943) teach a method for forming a metal pattern in a substrate, the method comprising the steps of:

- depositing a lower hardmask layer 40 on the substrate 10/20/30, the lower hardmask layer 40 (e.g. SiCOH) having a dielectric constant less than about 4.5 (i.e. a dielectric constant of about 2.5~8.0) (Fig. 1, page 3, lines 7-9 and page 8, lines 3-10);
- depositing a middle hardmask layer 50 on the lower hardmask layer 40 (Fig. 1);
- depositing a top hardmask layer 60 on the middle hardmask layer 50 (Fig. 1), the top hardmask layer 60 having a thickness less than about 200 Å (i.e. 100 ~2,000 Å, page 9, lines 3-4);

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- forming a first opening 90 in the top hardmask layer 60 in accordance with a first pattern, thereby exposing a portion of the middle hardmask layer 50 (Fig.2);
- forming a second opening 120 in said portion of the middle hardmask layer 50 in accordance with a second pattern and a corresponding opening 120 in the lower hardmask layer 40, thereby exposing a portion of the substrate 10/20/30 (Fig.4);
- forming an opening 125 in the substrate 10/20/30 (Fig.5);
- depositing metal 130 (copper) in the opening 125 in the substrate 10/20/30 (Fig.9); and
- removing the top hardmask layer 60 (Fig.10).

In contrast, Dalton et al. neither teach nor suggest that the top hardmask is of a material selected from the group consisting of refractory metals, refractory metal nitrides, refractory metal alloy, doped amorphous silicon and doped silicon. Instead, Dalton et al. teach that the top hardmask layer is of a material selected from the group consisting of silicon nitride, silicon carbide, OSG, silicon dioxide, organic sioxane polymer, carbon-or hydrogen-doped silicate glass, spin-on glass and fluorinated or non- fluorinated silicate glass.

The instant application is deemed to be directed to a nonobvious improvement over the aforementioned prior art. The improvement comprises using the aforementioned materials, which would optimize the damascene processing in forming a fine semiconductor device.

5. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Hsien-Ming Lee whose telephone number is 703-305-7341. The examiner can normally be reached on M-F (9:00 ~ 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on 703-306-2794. The fax phone number for the organization where this application or proceeding is assigned is 703-308-7382.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

Hsien-Ming Lee
Examiner
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A handwritten signature in black ink, appearing to read 'Hsien-Ming Lee', followed by a long horizontal flourish.

Nov. 12, 2003